

WHAT IS CLAIMED IS:

1. A filter element comprising
a plurality of resonators that are arranged in
5 series arms and parallel arms in a circuit,
at least one of the series-arm resonators
including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
parallel.
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2. The filter element as claimed in claim 1,
wherein at least one of the parallel-arm resonators
includes a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
15 parallel.
3. A filter element comprising
a plurality of resonators that are arranged in
series arms and parallel arms in a circuit,
20 at least one of the parallel-arm resonators
including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
parallel.
- 25 4. A filter element comprising
a plurality of resonators that are arranged in
series arms and parallel arms in a circuit,
at least the series-arm and/or parallel-arm
resonators at the first stage on the signal input side
30 including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
parallel.
5. The filter element as claimed in claim 1,
35 wherein the series-arm resonator including the
plurality of single-terminal pair piezoelectric thin-
film resonators connected in parallel has an admittance

matched with the admittance of at least one of the other series-arm resonators.

5 6. The filter element as claimed in claim 2,
wherein the parallel-arm resonator including the plurality of single-terminal pair piezoelectric thin-film resonators connected in parallel has an admittance matched with the admittance of at least one of the other parallel-arm resonators.

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7. The filter element as claimed in claim 1, wherein the single-terminal pair piezoelectric thin-film resonators connected in parallel have exciting parts that are uniform in size.

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8. The filter element as claimed in claim 1, which has a ladder filter structure.

20 9. The filter element as claimed in claim 1, which has a lattice filter structure.

10. The filter element as claimed in claim 1, wherein the single-terminal pair piezoelectric thin-film resonators each comprises:

25 a substrate that contains at least one of silicon, glass, and ceramics;

a piezoelectric substrate that contains at least one of aluminum nitride, zinc oxide, lead zirconate titanate, and lead titanate; and

30 an upper electrode film and a lower electrode film that are single-layer or multi-layer films containing at least one of aluminum, copper, gold, molybdenum, tungsten, tantalum, chromium, titanium, platinum, and rhodium.

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11. The filter element as claimed in claim 1, wherein the parallel-arm resonators each includes an

upper electrode film having a SiO₂ film formed thereon.

12. A filter device comprising:
a filter element; and
5 a package that houses the filter element,
the filter element including
a plurality of resonators that are arranged in
series arms and parallel arms in a circuit,
at least one of the series-arm resonators
10 including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
parallel.
13. A duplexer comprising
15 a transmission filter element and a reception
filter element,
the transmission filter element including a
plurality of resonators that are arranged in series
arms and parallel arms in a circuit,
20 at least one of the series-arm resonators
including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
parallel.
- 25 14. A duplexer comprising
a transmission filter element and a reception
filter element,
the transmission filter element including a
plurality of resonators that are arranged in series
30 arms and parallel arms,
at least one of the parallel-arm resonators
including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
parallel.
- 35 15. A high-frequency circuit that transmits and
receives radio signals, comprising:

a first amplifier that amplifies transmission signals;

a second amplifier that amplifies reception signals; and

5 a duplexer that includes a transmission filter element and a reception filter element,

the transmission filter element including a plurality of resonators that are arranged in series arms and parallel arms in a circuit, and

10 at least one of the series-arm resonators including a plurality of single-terminal pair piezoelectric thin-film resonators connected in parallel.

15 16. A high-frequency circuit that transmits and receives radio signals, comprising:

a first amplifier that amplifies transmission signals;

20 a second amplifier that amplifies reception signals; and

a duplexer that includes a transmission filter element and a reception filter element,

25 the transmission filter element including a plurality of resonators that are arranged in series arms and parallel arms in a circuit, and

at least one of the parallel-arm resonators including a plurality of single-terminal pair piezoelectric thin-film resonators connected in parallel.

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17. A high-frequency circuit that transmits radio signals, comprising:

an amplifier that amplifies transmission signals; and

35 a filter element that filters the transmission signals,

the filter element including a plurality of

resonators that are arranged in series arms and parallel arms in a circuit, and

at least one of the series-arm resonators including a plurality of single-terminal pair
5 piezoelectric thin-film resonators connected in parallel.

18. A high-frequency circuit that transmits radio signals, comprising:

10 an amplifier that amplifies transmission signals; and

a filter element that filters the transmission signals,

the filter element including a plurality of
15 resonator that are arranged in series arms and parallel arms in a circuit, and

at least one of the parallel-arm resonators including a plurality of single-terminal pair
piezoelectric thin-film resonators connected in
20 parallel.